Progress Towards a NASA Earth Science Reuse Enablement System (RES)

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About the Reuse Working Group

- Purpose
  - Address technical issues required to enable and facilitate reuse of software assets, including open source products, within the NASA Earth science community.
- Goals
  - To spend less time, money, and effort on software development.
  - To increase productivity and improve quality through reuse.
  - To increase the number of available reusable assets.
- At right are the main types of WG activities.

Reuse Implementation Projects
Efforts that result in the publication or use of a reusable component

Outreach and Education Activities
Efforts that increase community awareness and understanding of benefits, best practices, etc.

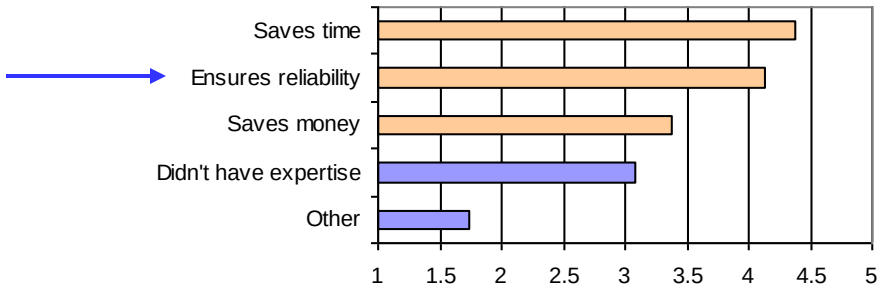
Support/Enablement Activities
Efforts that provide tools and mechanisms to enable reuse

Reuse Incentive Activities
Awards and structural changes that directly or indirectly encourage reuse

Policy Change Activities
Efforts to reduce policy barriers to reuse

Reuse Surveys

- A survey on the reuse practices of the Earth science community was conducted in 2004 and repeated in 2005 with OMB approval and a wider audience.
- Both surveys show the same basic results:
  - Developers need to be able to easily locate and evaluate available reusable artifacts.
  - Top three motivations for reuse match the WG goals:
    - Saving time
    - Ensuring reliability
    - Saving money
  - *Top three factors to increase reuse*:
    - Earth science catalog/repository of reusable assets
    - Greater use of open source licensing
    - More education and guidance on reuse
  - Top two barriers to reuse:
    - Did not know reusable assets existed
    - Did not know where to look for reusable assets



Areas where the WG is informing and improving.

Source: Marshall, J.J.; Olding, S.W.; Wolfe, R.E.; Delnore, V.E., "Software Reuse Within the Earth Science Community," Geoscience and Remote Sensing Symposium, 2006. IGARSS 2006. IEEE International Conference on, pp.2880–2883, July 31, 2006 – Aug. 4, 2006.

RES Background

- Based on the 2004 survey results, the WG recommended that an Earth science repository/catalog system be created to meet the needs of the Earth science software developer community.
  - Having a catalog/repository for reusable Earth science assets is one of the best means of increasing reuse in the community.
  - It would also address the top two barriers to reuse.
- Around the same time, the WG developed use cases and requirements for the proposed Reuse Enablement System (RES), which were later formalized and revised for clarity.
- In response to the recommendation, NASA Headquarters tasked the WG to perform a trade study to understand the role of existing systems as a potential platform for enabling software reuse.

See http://www.esdswg.com/softwarereuse/Resources/res for the use cases and requirements documents.

RES Trade Study

- The WG conducted a trade study of various NASA and non-NASA sites, which was completed in 2005.
- The results showed that none of the existing systems satisfied the needs of the community of Earth science software developers.

Requirement/Feature	GCMD	GSFC OSS	Ames OSS
Domain	Earth science	Earth and space science	General science
Type of Assets	Data sets, data services	Open source packages	Open source packages
Register User	☆☆☆	☆☆☆	☆☆☆
Contribute / Update Assets	★★☆	★☆☆	★☆☆
System Feedback	★★☆	★★☆	★★☆
Automatic Notifications	★★★	★☆☆	★☆☆
Discovering Assets	Hierarchy, Search	List	List
Register Asset Usage	☆☆☆	★★★	★★★
Provide Asset Reviews	☆☆☆	★☆☆	☆☆☆
Monitoring Feedback	★☆☆	★★☆	★☆☆
Secure Login or Registration	N/A	No	No
Catalog or Repository	Catalog	Both	Both
Operation Support	Large	Small	Small
Technology	RSYNC, Zope, CVS, Linux, Java, and others	PHP	JavaServer pages

A sample of the trade study results is shown here.

Source: NASA Earth Science Data Systems Software Reuse Working Group. 2005. Reuse Enablement System (RES) Trade Study Report, p. 38. http://www.esdswg.com/softwarereuse/Resources/res/RESTradeStudy.pdf/view

RES Architecture Study

- The WG then conducted an architecture study to determine what existing software package or system was most suited for reuse in building the RES, which was completed in 2007.
- The results showed that the XOOPS content management system met the most requirements and would take the least time to develop.

Approach Studied	# of Requirements			Effort Estimate [months]
	Met	Not Met	Partially Met	
XOOPS	40	9	5	8.12
Savane	24	20	10	34.10
GCMD	26	24	4	N/A
GForge	20	26	8	N/A

A summary of the architecture study results is shown here.

Note: Efforts for GCMD and GForge were not estimated due to their similarity to Savane in terms of requirements met.

Source: NASA Earth Science Data Systems Software Reuse Working Group. 2007. Reuse Enablement System (RES) Architecture Study. p. 2. http://www.esdswg.com/softwarereuse/Resources/res/RESArchStudy.pdf/view

Prototype RES Development

- In accordance with the architecture study results, the WG began work on developing a prototype RES built using XOOPS in 2007–2008.
- To meet all of the previously developed RES requirements:
  - Some additions were made, including installing some modules to provide functionality beyond that of the base XOOPS package.
  - Some modifications were made, to the added modules and the base system, as needed.

RES Estimates

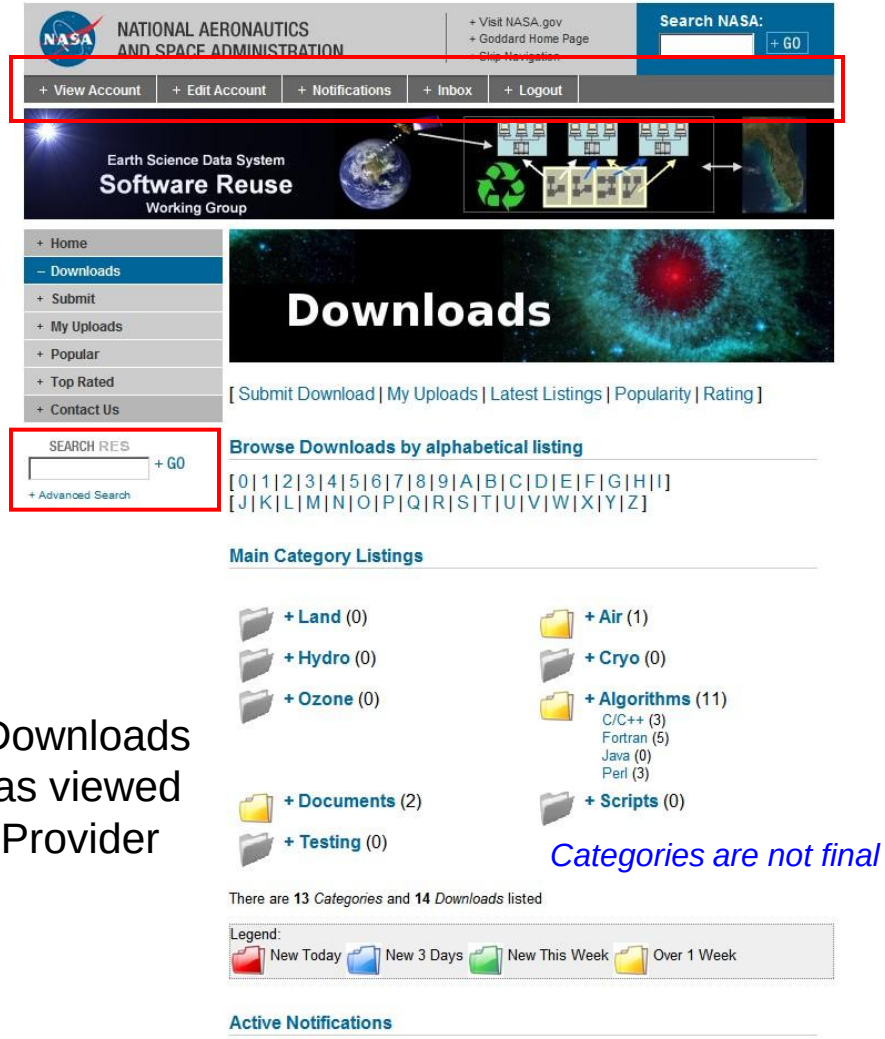
- As part of its recommendation, the WG estimated the size of the target audience for the RES and the number of assets the RES might contain.
- Target audience
  - NASA's workforce consists of about 82,000 people.
  - About 4% of them are in Earth science, and of these, about 60% are scientists and engineers.
  - Therefore, a lower limit to the audience is about 2,000 people.
- Number of assets
  - As of February 2009, SourceForge contained more than 230,000 projects and over 2,000,000 registered users. [http://sourceforge.net/about]
  - Assuming one unique provider per project, about 10% of users are providers, and this estimate is used for the RES.
  - Based on the above audience estimate, if 10% of the users are providers and each offers 1 asset, the RES could contain at least 200 assets.

The software reuse peer-recognition award developed by the WG can provide an incentive for users to contribute assets to the RES.

Source: Marshall, J.J.; Downs, R.R.; Samadi, S.; Gerard, N.S.; Wolfe, R.E., "Software Reuse to Support Earth Science," Journal of Frontiers of Computer Science and Technology, 2008, Vol. 2, No. 3, pp. 296–310

Views of the Prototype (1 of 3)

Home page as viewed by an Anonymous User



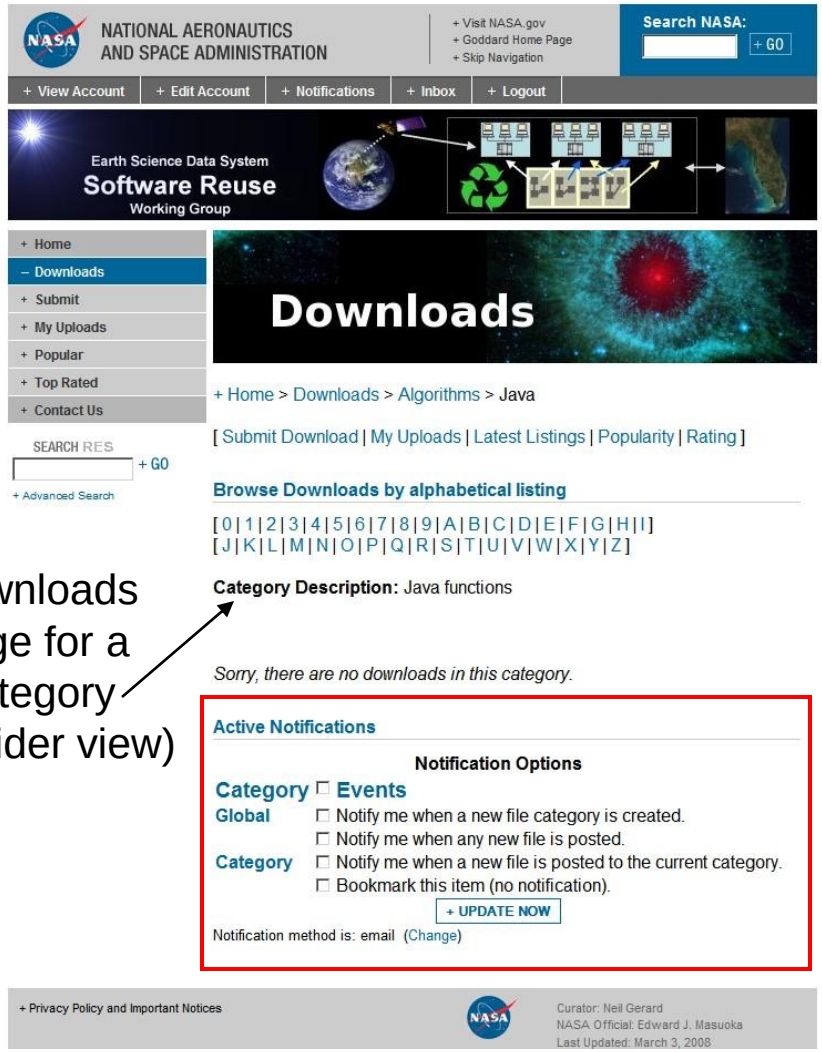
Main Downloads page as viewed by a Provider

Consumers would also see this note on the main downloads page (at right):

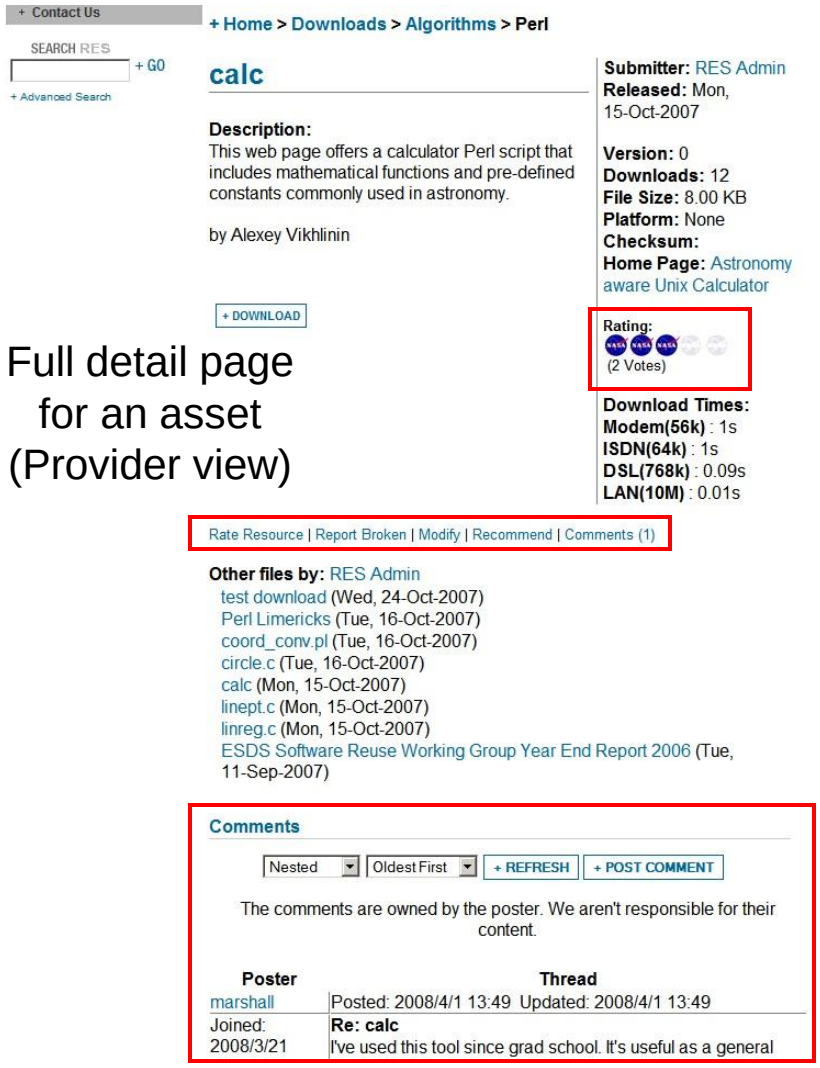
Note: You currently do not have the ability to upload files. If you would like to do so, find out how to become a provider!

Views of the Prototype (2 of 3)

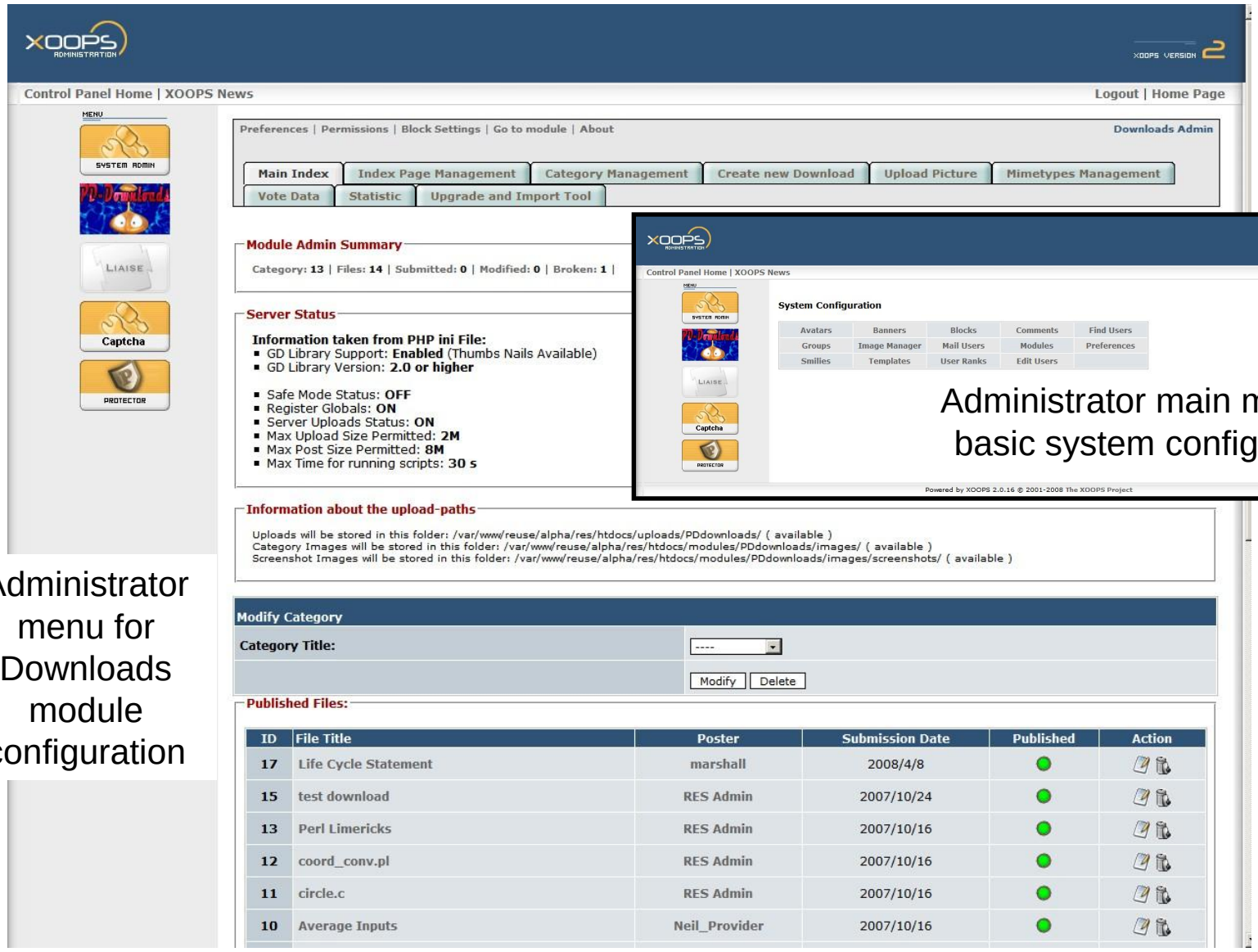
Downloads page for a category (Provider view)



Full detail page for an asset (Provider view)



Views of the Prototype (3 of 3)



Administrator main menu for basic system configuration

Administrator menu for Downloads module configuration

Towards Implementing the RES

- The WG developed a test plan for formal testing of the prototype.
- The WG developed a set of policies for the operation and maintenance of the RES.
  - Additional reviews by other relevant offices (e.g., legal, tech. transfer, NASA Headquarters) are planned.
- The WG documented and packaged the RES for installation at other sites.
- Some of the Earth science decadal survey missions (e.g., SMAP) are beginning to implement instances of the RES.
- This work was performed primarily in 2009–2010.

See http://www.esdswg.com/softwarereuse/Resources/res for v1.0 of the test plan and policy documents.

Centralized vs. Distributed

- The WG's original recommendation to NASA was for the RES to be a single, centralized system.
- Recent direction from NASA has indicated that new missions could benefit from the implementation of a set of distributed systems, run on a per-mission basis.
- Centralized system:
  - One-stop shopping (helps break down barriers to reuse)
  - Domain-specific (focused on Earth science)
  - Operated and maintained by one entity
- Distributed systems:
  - Area-specific (focused on specific sub-domains of Earth science)
  - Generally smaller and thus easier to operate and maintain
  - Allows for some customization based on mission, audience, etc.

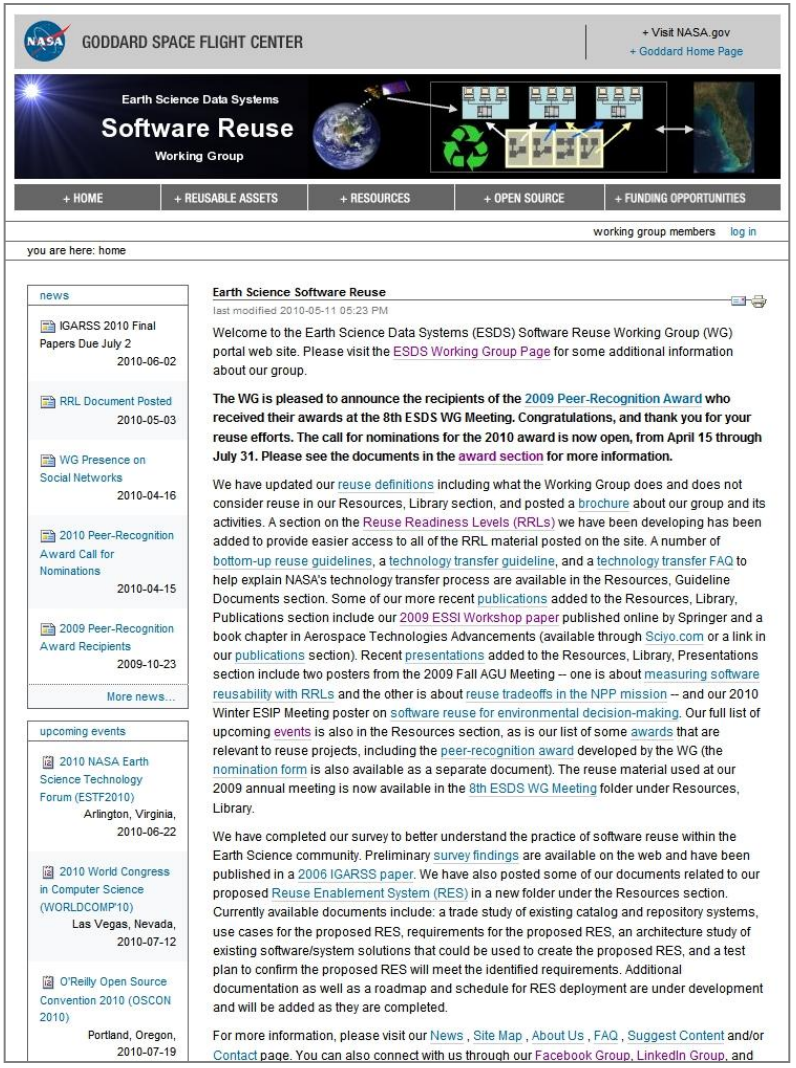
Conclusions and Future Work

- The WG conducted surveys of the Earth science software/system development community that indicated a desire for domain-specific catalogs of reusable assets.
- The WG performed a number of studies and development efforts to create a prototype of such a Reuse Enablement System (RES).
- This prototype is starting to be used by the near-term Earth science decadal survey missions.

- The WG is working with the decadal survey missions, including SMAP and ICESat-2, to assist them in creating their own RES instances, and is starting to reach out to other missions, such as DESDynI and OCO-2.
- The WG is also working to standardize the software packaging data model for assets cataloged and stored within each RES, to help with potential cross-system searching or indexing.

Reuse WG Contact Information

- NASA Earth Science Data Systems (ESDS) Working Groups
  - Coordinator, Frank Lindsay (http://esdswg.eosdis.nasa.gov/)
- Software Reuse Working Group
  - Chair: Chris A. Mattmann (chris.a.mattmann@jpl.nasa.gov)
  - Co-chair: Robert R. Downs (rdowns@ciesin.columbia.edu)
  - General Info: James J. Marshall (James.J.Marshall@nasa.gov)
- Social Networks
  - http://twitter.com/esdswg_reuse
  - http://www.facebook.com/group.php?gid=117453644936920
  - http://www.linkedin.com/groups?gid=2964349



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